REMARKS

By this amendment, independent claims 20, 25, and 29 have been amended. Support for the amendments can be found at, *inter alia*, page 11, line 18, and page 12, lines 30-31, of the specification. Claims 20, 22, 24, 25, 27-29, and 31 are presented for further examination.

Claim Rejections Under 35 U.S.C. § 102

The rejection of claims 25 and 28 under 35 U.S.C. § 102(b) as allegedly anticipated by NPL: "Controlled nitrogen incorporation at the gate oxide surface," June 1995 ("Hattangady") is respectfully traversed with respect to the amended claims.

Amended independent claim 25 recites a process for treating a substrate by plasma nitridation, comprising forming an oxide film on the substrate and irradiating plasma on the oxide film using a mixed gas comprising argon gas and nitrogen gas to form an oxynitride film. The plasma is irradiated on the oxide film at a temperature of 250 to 500°C and under a pressure of 7 to 260 Pa. A nitrogen atom content in the oxynitride film has a distribution such that the maximum value Ns of the nitrogen atom content in the oxynitride film at a surface of the oxynitride film opposite a surface facing the substrate is 10 to 40 atomic percent, and the maximum value Nb of the nitrogen atom content in the oxynitride film at the surface facing the substrate side is 0 to 10 atomic percent. The ratio Ns/Nb is 2 or more. The oxynitride film has an electrical film thickness from 1.0 to 2.5 nm.

Although Hattangady discloses plasma nitridation using He and N_2, Hattangady does not disclose or suggest plasma nitridation using argon and nitrogen gas. Additionally, Hattangady does not disclose or suggest the electrical film thickness of the oxynitride film.

The process of amended independent claim 25 provides the following advantages: (1) the thickness of the oxynitride film could be reduced compared

to the silicon oxide because of the low leak current (see page 8, line 7 – page 9, line 7, of the present specification), and (2) prevention of penetration of boron or the like (see page 9, line 28 – page 10, line 27, of the present specification). The process of amended independent claim 25 provides such advantages by combining the features recited in the claim to form an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm. For example, the process of amended independent claim 25 forms an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm by combining temperature and pressure of the plasma processing, Ns, Nb, and Ns/Nb.

Accordingly, withdrawal of the rejection of claims 25 and 28 as allegedly anticipated by Hattangady is respectfully requested.

Claim Rejections Under 35 U.S.C. § 103

- I -

The rejection of claims 20, 22, 24, and 27 under 35 U.S.C. § 103(a) as allegedly unpatentable over Hattangady in view of JP2000-294550 ("Murakawa") is respectfully traversed with respect to the amended claims.

Amended independent claim 20 recites a process for treating a substrate by plasma nitridation, comprising providing the substrate having an oxide film thereon and irradiating plasma having an electron temperature of 0.5 to 2.0 eV on the oxide film using a mixed gas comprising argon gas and nitrogen gas to form an oxynitride film. The plasma is irradiated on the oxide film at a temperature of 250 to 500°C and under a pressure of 7 to 260 Pa. A nitrogen atom content in the oxynitride film has a distribution such that the maximum value Ns of the nitrogen atom content in the oxynitride film at a surface of the oxynitride film opposite a surface facing the substrate is 10 to 40 atomic percent, and the maximum value Nb of the nitrogen atom content in the oxynitride film at the surface facing the substrate side is 0 to 10 atomic percent. The ratio Ns/Nb is 2 or more. The oxynitride film has an electrical film thickness from 1.0 to 2.5 nm.

As noted above, although Hattangady discloses plasma nitridation using He and N_2, Hattangady does not disclose or suggest plasma nitridation using argon and nitrogen gas. Additionally, Hattangady does not disclose or suggest the electrical film thickness of the oxynitride film.

The Office Action acknowledges that Hattangady fails to disclose "irradiating plasma having an electron temperature of 0.5 eV to 2.0 eV." (Page 5). Accordingly, the Office Action cites Murakawa as allegedly disclosing "a nitriding processing using an electron temperature of about 1 eV or less." (Page 5).

Although Murakawa discloses forming an oxynitride film on a substrate directly (see paragraph [0080]), Murakawa does not disclose or suggest a method comprising providing a substrate having an oxide film thereon and plasma nitriding the oxide film. As Murakawa forms an oxynitride film on a substrate using plasma including N_2 and O_2 gases together (see paragraph [0080]), Murakawa cannot form the nitrogen atom distribution in the oxynitride film recited in independent claim 20. Although Murakawa discloses an oxynitride film having a thickness of 1 nm or less at oxide-film equivalent conversion film thickness, Murakawa does not disclose or suggest forming an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm, as recited in independent claim 20.

The process of amended independent claim 20 provides the following advantages: (1) the thickness of the oxynitride film could be reduced compared to the silicon oxide because of the low leak current (see page 8, line 7 – page 9, line 7, of the present specification), and (2) prevention of penetration of boron or the like (see page 9, line 28 – page 10, line 27, of the present specification). The process of amended independent claim 20 provides such advantages by combining the features recited in the claim to form an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm. For example, the process of amended independent claim 20 forms an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm by combining electron temperature of the

irradiation plasma, temperature and pressure of the plasma processing, Ns, Nb, and Ns/Nb.

Further, contrary to the assertion in the Office Action, it would ***not*** have been obvious for one of ordinary skill in the art to combine Hattangady and Murakawa. In particular, Murakawa forms an oxynitride film on a substrate using plasma including N_2 and O_2 gases together (see paragraph [0080]), while Hattangady forms an oxide film on a substrate and then nitrides the oxide film. Accordingly, as Murakawa and Hattangady have quite different ways of forming an oxynitride film, one of ordinary skill in the art would not seek to combine Hattangady and Murakawa.

Accordingly, withdrawal of the rejection of claims 20, 22, 24, and 27 as allegedly unpatentable over Hattangady in view of Murakawa is respectfully requested.

- II -

The rejection of claims 29 and 31 under 35 U.S.C. § 103(a) as allegedly unpatentable over Hattangady in view of U.S. Patent No. 6,136,654 ("Kraft") and Murakawa is respectfully traversed with respect to the amended claims.

Amended independent claim 29 recites a process for forming a gate oxynitride film, comprising providing a substrate having an oxide film thereon and irradiating plasma having density of $1x10^{10}$ to $5x10^{12}/cm^3$ and an electron temperature of 0.5 to 2.0 eV on the oxide film using a mixed gas comprising argon gas and nitrogen gas to form the oxynitride film. The plasma is irradiated on the oxide film at a temperature of 250 to 500°C and under a pressure of 7 to 260 Pa. A nitrogen atom content in the oxynitride film has a distribution such that the maximum value Ns of the nitrogen atom content in the oxynitride film at a surface of the oxynitride film opposite a surface facing the substrate is 10 to 40 atomic percent, and the maximum value Nb of the nitrogen atom content in the oxynitride film at the surface facing the substrate side is 0 to 10 atomic percent. The ratio Ns/Nb is 2 or more. The oxynitride film has an electrical film thickness from 1.0 to 2.5 nm.

As noted above, although Hattangady discloses plasma nitridation using He and N_2, Hattangady does not disclose or suggest plasma nitridation using argon and nitrogen gas. Additionally, Hattangady does not disclose or suggest the electrical film thickness of the oxynitride film.

The Office Action acknowledges that Hattangady fails to disclose "irradiating plasma having a density of $1x10^{10}$ to $5x10^{12}/cm^3$ and an electron temperature of 0.5 eV to 2.0 eV." (Page 7). Accordingly, the Office Action cites Kraft as allegedly disclosing "a plasma density . . . between $1x10^{10}$ to $1x10^{12}$ cm^{-3} for a plasma nitridation" (page 7) and Murakawa as allegedly disclosing "a nitriding processing using an electron temperature of about 1 eV or less" (page 7).

Although Kraft discloses plasma nitridation using N_2, NH_3, NO and N_2O, Kraft does not disclose or suggest plasma nitridation using argon and nitrogen gas. Kraft discloses that the plasma is irradiated on the oxide film under a pressure of 1 to 50 mTorr (0.13 to 5.7 Pa). (Column 4, Lines 7-8). When an oxide film is irradiated by plasma under such a low pressure as disclosed in Kraft, the oxide film suffers damage by the high kinetic energy of the plasma. Further, Kraft does not disclose or suggest the electrical film thickness of the oxynitride film, as recited in independent claim 29.

Although Murakawa discloses forming an oxynitride film on a substrate directly (see paragraph [0080]), Murakawa does not disclose or suggest a method comprising providing a substrate having an oxide film thereon and plasma nitriding the oxide film. As Murakawa forms an oxynitride film on a substrate using plasma including N_2 and O_2 gases together (see paragraph [0080]), Murakawa cannot form the nitrogen atom distribution in the oxynitride film recited in independent claim 20. Although Murakawa discloses an oxynitride film having a thickness of 1 nm or less at oxide-film equivalent conversion film thickness, Murakawa does not disclose or suggest forming an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm, as recited in independent claim 29.

The process of amended independent claim 29 provides the following advantages: (1) the thickness of the oxynitride film could be reduced compared to the silicon oxide because of the low leak current (see page 8, line 7 – page 9, line 7, of the present specification), and (2) prevention of penetration of boron or the like (see page 9, line 28 – page 10, line 27, of the present specification). The process of amended independent claim 29 provides such advantages by combining the features recited in the claim to form an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm. For example, the process of amended independent claim 29 forms an oxynitride film having an electrical film thickness from 1.0 to 2.5 nm by combining density and electron temperature and pressure of the plasma processing, Ns, Nb, and Ns/Nb.

Further, as noted above, contrary to the assertion in the Office Action, it would ***not*** have been obvious for one of ordinary skill in the art to combine Hattangady and Murakawa. In particular, Murakawa forms an oxynitride film on a substrate using plasma including N_2 and O_2 gases together (see paragraph [0080]), while Hattangady forms an oxide film on a substrate and then nitrides the oxide film. Accordingly, as Murakawa and Hattangady have quite different ways of forming an oxynitride film, one of ordinary skill in the art would not seek to combine Hattangady and Murakawa.

Accordingly, withdrawal of the rejection of claims 29 and 31 as allegedly unpatentable over Hattangady in view of Kraft is respectfully requested.

In view of the foregoing, the application is respectfully submitted to be in condition for allowance, and prompt favorable action thereon is earnestly solicited.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and

please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #101249.55470US).

Respectfully submitted,

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